# SP-2

Hand-Held Spirometer

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English

# Introduction

The SP-2 Hand-Held Spirometry Unit features three pulmonary function testing modes for the measurement of inspiratory and expiratory values. The large LCD screen instantly show pulmonary test results and provides a clear and comprehensive result analysis in a number of different formats. All tests and settings are initiated via an easy to use interface.

The sensor mouthpiece is a disposable, single patient sensor/filter assembly eliminating the need to clean the sensor after each use.

All functions and settings are selected via menus displayed on the LCD with direct test function menu options for measuring the following:

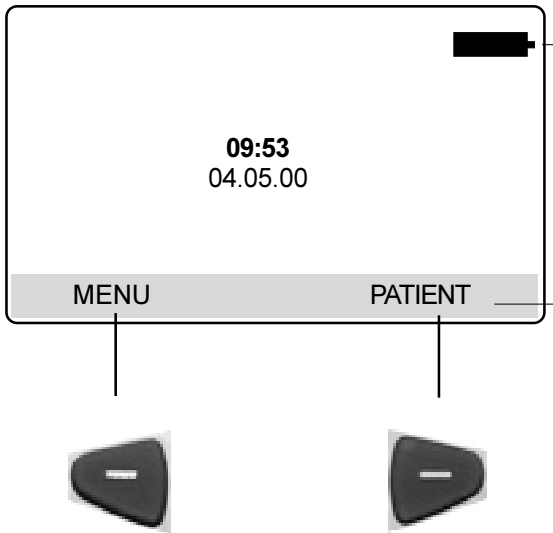
- FVC Forced Vital Capacity
- SVC Slow Vital Capacity
- MVV Maximum Voluntary Ventilation (Option)

1. **Battery Compartment**
   Two, 1.5V non rechargeable AA batteries
2. **12 Alpha numeric keys**
   For text / numerical input e.g. patient data, calibration data etc.
3. **Three Direct Function keys:**
   **Print / Send**. This key initiates transmission over the infrared interface to a compatible printer using the standard data association protocol.
   **LCD Backlight Key -** The middle key is the ON/OFF control for the LCD backlight. The backlight is automatically switched off after approximately 10 seconds.
   The **START/STOP** (and **ON/OFF)** key has three functions:
   - Switches the unit on.
   - When the unit is switched on and in test mode, this key starts / stops a measurement.
   - When the unit is switched on and not in test mode, this key switches the unit off (press for 2-3 seconds).
4. **Four (menu navigation/selection) Function keys:**
   **LEFT / RIGHT keys -** The functions of these keys depends on the menu displayed and is shown in the bottom line of the LCD line. In general however, the left softkey selects the functions and the right key acts in a similar way to the 'enter' key in a PC. See following pages.
   The **UP and DOWN keys** move the cursor in the menu fields to highlight the menu options. These two keys can also act as extra function keys - in this case the function is shown in the bottom line of the LCD line.
5. **LCD**
6. **Infrared Data Interface (not seen)**
7. **Disposable Mouthpiece**

English

## Main Menu

**1. Press the ON key. The Introduction screen is displayed:**




**Battery Indicator -** Displayed when battery life is limited - change the batteries as soon as possible.

When this symbol flashes, it indicates critical battery voltage. Tests can be completed but all other functions ( e.g. printing, backlight) are inhibited - change batteries immediately.

**Softkey Line -** Defines the left / right softkey functions

**Press the left soft key to enter the MAIN MENU**

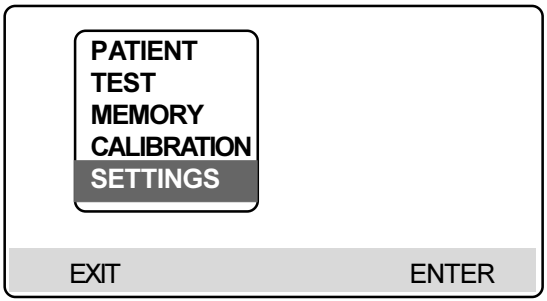
**(Page 5)**

**Press the right soft key to enter the patient screen**

**(Page 6)**

# Main Menu

**If using the option for the first time select the required spiro settings and Spiro Standard.** Select 'Settings' from the main menu to display the Spiro settings - details of all spiro settings are given on the following pages. *All these settings are stored when the unit is switched off.*



EXIT/MENU — Return to introduction screen/main menu

CURSOR UP /DOWN — Move cursor (highlight bar) up/down

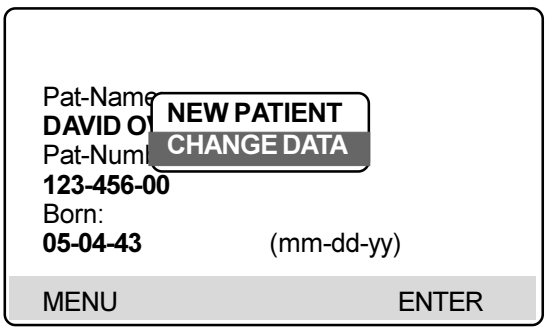
ENTER — Select highlighted item

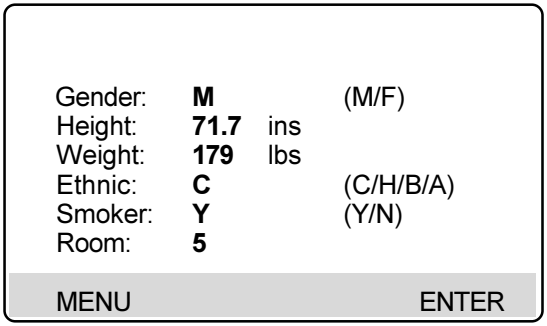
*Details of all settings are detailed later.*

English

# Entering Patient Data

**2. From the introduction screen press the RIGHT soft key to enter patient data. (From the main menu, highlight 'patient' and press the RIGHT soft key).**




**3. Select a new patient or change existing patient data with the up/down soft keys and press the RIGHT soft key to confirm.**

For a required character, a key must be pressed one or more times dependant on whether in a numerical or letter field. For example in an alpha numeric field (e.g. patient name) the '2' key is:
1st press 'A'; 2nd press 'B'; 3rd press 'C'; 4th '1'; 5th 'A' etc.
In a numeric field the number comes first.

MENU — Return to main menu

Toggle between choices

Delete last character entered or Toggle between choices

ENTER — Enter details / Go to next line

# Entering Patient Data

Each printout is complete with the name and other information concerning the patient. Before beginning a recording, the patient data should be entered. The following parameters have to be entered:

**Pat-Name:** Alpha-numeric field

**Pat-Number:** Alpha-numeric field

**Born:** Enter patients` data of birth in the order shown (defined in system settings)

**Gender:** Select `M` (male) or `F` (female). Use up/down toggle keys to change.

**Height:** Height in centimeters (numeric field)
(or inches (scaled to 1/10 inch), depending on unit setup)

**Weight:** Weight in kilograms (numeric field)
(or pounds, depending on unit setup).

**Ethnic:** Enter patients race - either:

W/B: `W` for White, `B` for Black
or C/H/B/A: `C` for Caucasian, `H` for Hispanic, `B` for Black;

`A` for Asian. Use up down toggle keys

**Smoker:** Enter `Y` (yes) or `N` (no). Use up/down toggle keys to change.

**Room:** Alpha-numeric field

English

**4. Insert a new disposable sensor.**

*See page 26*

**WARNING**

THE DISPOSABLE MOUTHPIECE IS DESIGNED FOR ONE-TIME USE TO MINIMIZE THE DANGER OF CROSS CONTAMINATION - DO NOT USE THE MOUTHPIECE FOR MORE THAN ONE PATIENT.

**5. Calibrate the Unit**

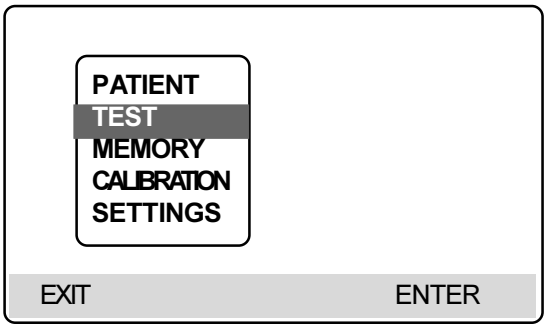
**The unit must be calibrated**

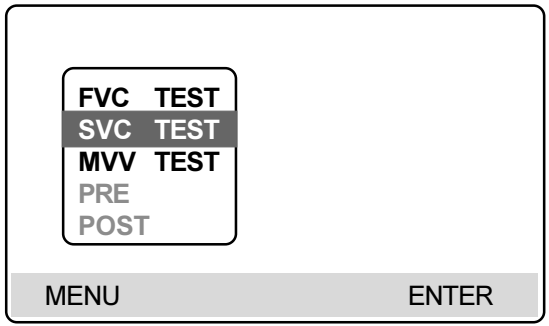
- **At the beginning of each day**
- **When a significant temperature or pressure difference occurs**

*The calibration procedure is detailed later.*

# Selecting the Test

**6. From the main menu Select the Test Option**



EXIT/MENU Return to introduction screen/main menu

CURSOR UP /DOWN Move cursor (highlight bar) up/down

ENTER Select highlighted item

English

# Taking a Test

**7. For all tests the procedure is the same**

**The message `**

| |
|---|
| before the measurement:<br>hold the sensor still<br>*** press START *** |

**appears on the display.**

**8. Press the START / STOP key once**

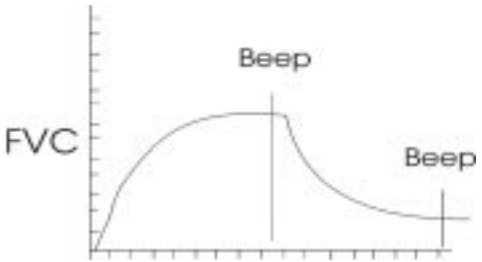
*The device must be held upright and quite still and no air should be breathed into the device for at least one second before the START key is pressed.*

**As soon as the patient starts to breath into the Mouthpiece, the unit begins to record the flow. The corresponding curve is represented on the display. The break-off point for the measurement is reached automatically (or when the Stop key is pressed).**

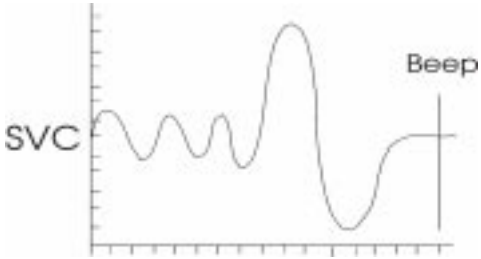
# Taking a Test

Audible indications are given for each test as follows:

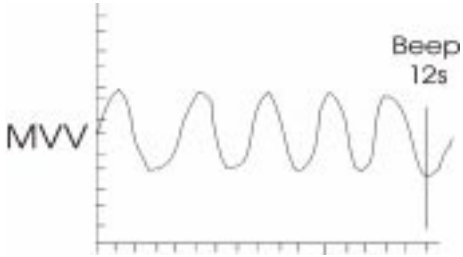
FVC A beep is given at the end of exhalation (indicating that inhalation (if required) can begin), and at the end of the test.




SVC A beep is given when no flow is detected (end of test) or in any case after 30 seconds.




MVV A beep is given after 12 secs (end of test).




English

**WARNING:** FALSE MEASUREMENTS CAN RESULT WHEN THE SENSOR IS NOT HELD VERTICALLY - ENSURE THAT THE UNIT IS HELD UPRIGHT WHEN TAKING TESTS.

**CAUTION:** **The SP-2 is a sensitive measuring device and must always be handled with care. Do not allow it to be dropped or subjected to any sudden blows.**

## Forced Vital Capacity (FVC) Test

For this test the patient must exhale as quickly as possible from the time of starting the test.

**Note:** **The FVC test employs the `Back extrapolation` method. If the extrapolated volume is too large (>0.15 liters or 5% of FVC), then a warning appears on the display**

To carry out the test for Forced Vital Capacity (FVC), highlight the `FVC` option in the test menu (previous page) and press the Enter key. The corresponding coordinate presentation appears on the display.

The patient must exhale as quickly as possible from the time of starting the test so be sure that he understands what is required of him. If inspiratory measurements are required, the exhalation can be immediately followed by a maximum inhalation. The inspiration results will be given on the printout.

The coordinates represent the graph on which the curve will be drawn with the respiratory volume in liters being represented on the vertical axis and the time in seconds on the horizontal axis.

*ALSO SEE `SPIROMETRY TIPS` AT THE END OF THIS BOOK*

# Taking a Test

## Slow Vital Capacity (SVC) Test

The patient should breathe normally 3 times and then inhale to the maximum extent of total lung capacity and then expire to the maximum extent. Make sure that the patient understands what is required of him.

## MVV Test

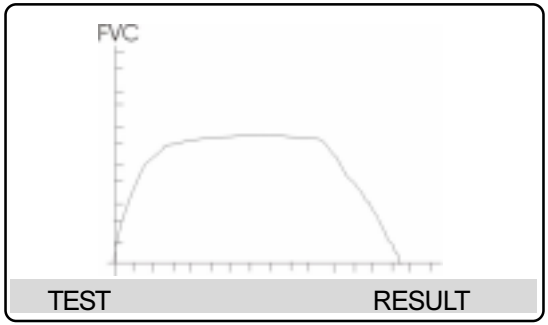
The patient should breathe as deeply and as rapidly as possible over a period of 6 to 12 seconds.

WARNING **CARE SHOULD BE EXERCISED WHEN PERFORMING THIS TEST AS THERE IS A DANGER OF HYPERVENTILATION. ENSURE THAT THE PATIENT IS SITTING DOWN.**

English

# Screen Information

## Curves



TEST Return to test menu

No function in this screen

No function in this screen

RESULTS Display the results

## Tabular

Once the test is completed, the measurement results are calculated.

**To display the results in Tabular form, select RESULT (right key from the graph display).**

Separate result tables are given for each test (FVC, SVC and MVV). The FVC screen displayed below is typical.

**FVC**

| | MEAS | PRED | %Pred |
|---|---|---|---|
| FVC | 4.31 | 4.82 | 87 |
| FEV1 | 3.50 | 4.532 | 79 |
| FEV1/FVC | 8.23 | 9.36 | 76 |
| FEV3/FVC | -- | -- | -- |
| FEF.2-1.2 | -- | -- | -- |
| FEF25-75% | -- | -- | -- |

TEST CURVE

TEST Return to test menu

Previous result page / Next result page. Toggle through all calculated results. The last page gives the interpretation.

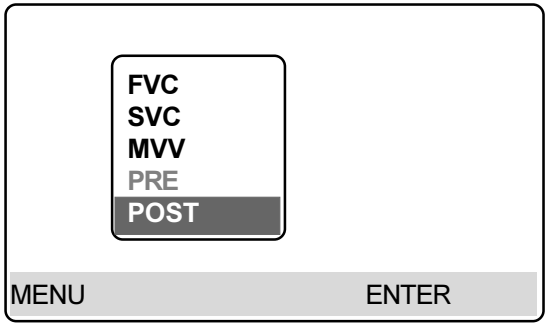
CURVE Return to Test

English

# Post-Medication Tests

**In order to carry out post-medication tests for comparison, select the `POST` from the test menu.**

**NOTE:** **THE POST OPTION IS ONLY AVAILABLE WHEN A `PRE` TEST HAS BEEN CARRIED OUT. WHEN A POST MEASUREMENT IS NOT POSSIBLE THE MENU OPTION IS DIMMED. ON SWITCH ON, THE `POST` OPTION IS AVAILABLE FOR THE LAST PATIENT BEFORE THE UNIT WAS SWITCHED OFF.**




The post-medication tests are carried out in the same way as the premedication tests. The printout following post-medication tests will give the curves of both pre and post-medication tests (the post medication curve is dashed). The measurement results are shown as the best results (pre/post), results as a percentage of those predicted, (both pre and post) and the percentage change (i.e. difference) between pre and post-medication results.

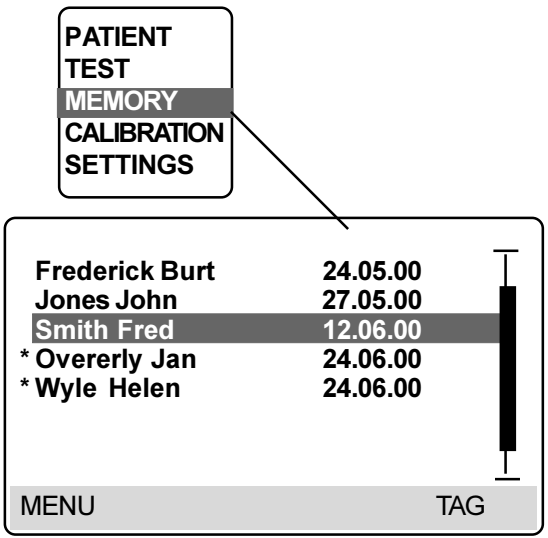
**TO MINIMIZE THE DANGER OF CROSS INFECTION, DISPOSE OF THE MOUTHPIECE IMMEDIATELY AFTER ALL TESTS HAVE BEEN CARRIED OUT.**

# Memory

The memory allows approximately 50 recordings (dependent on size and parameters specified when the recording was taken) to be stored, displayed and printed.

**The results of the current patient are automatically stored when a new patient is entered. When the unit is switched off, the current patient and test results are remembered and are available the next time the device is switched on.**

When no more recordings can be stored the message `MEMORY FULL` is displayed. Old recordings must be deleted before further recordings can be stored. Enter the memory screen from the main menu:




English

# Memory

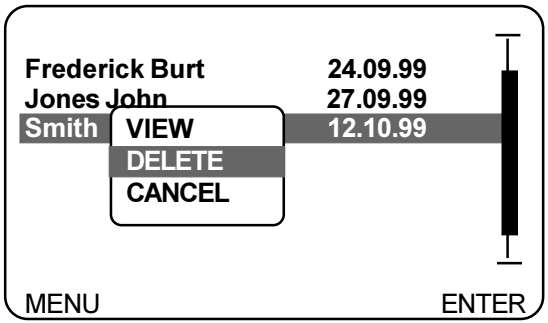
| | |
|---|---|
| MENU | Go to Memory menu |

| | |
|---|---|
| UP | Highlight previous patient |
| DOWN | Highlight next patient |

| | |
|---|---|
| TAG | Mark / Unmark highlighted patient for deleting (see next page). Tagged recordings are indicated by an asterisk before the name. |

# Memory

## Menu



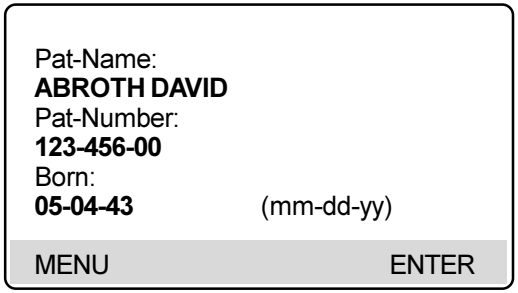
| | |
|---|---|
| MENU | Go to Main menu |
| UP | Highlight previous menu entry |
| DOWN | Highlight next menu entry |
| ENTER | When View selected - reads highlighted recording. (see next page)<br>When Delete selected enters further menu options for the deletion of all or only tagged recordings.<br>When cancel selected - returns to memory screen. |

English

# Displaying Test Data From a Stored Patient

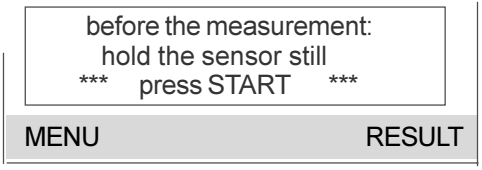
1. **From the memory menu, highlight the required patient and select the view option as described previously.**

2. **Wait a few seconds for the program to display and retrieve the selected patient data.**




3. **Return to the main menu and select the test option.**

4. **The test screen is displayed:**




5. **Select RESULT to display the test results for the selected test. Note that the stored tests can only be displayed in tabular form.**

# Obtaining a Printout

Printing is carried out via any printer that has an infra red connector.

To obtain a printout of the currently displayed recording:

1. **Point the unit towards the printer and press and release the Print / Send key.**
2. **A beep indicates when the data has been downloaded to the printer and the SP-2 can be withdrawn.**

The graphs are printed according to the print settings defined and will always include the following:

- The patient data.
- The selected norm values.
- The date of last calibration.
- The diagnostic statement (if enabled in Settings menu).
- The date and time of the printout.
- The software version.

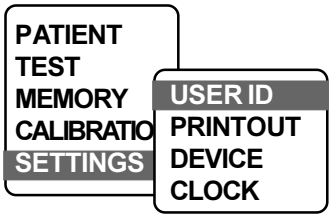
**The print settings are detailed in the following pages.**

English

# Spiro Settings (User Identification)

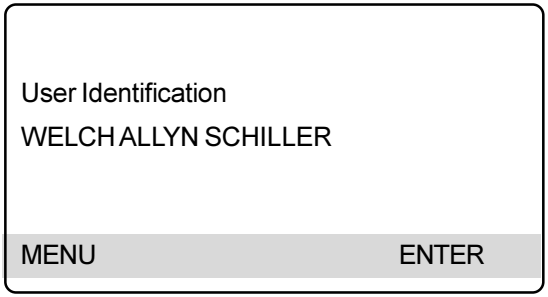
The settings menu option defines all the general settings. Settings made here are remembered when the unit is switched off. For normal use, the settings are made when the unit is first commissioned. However, the settings can be easily changed at any time for comparison purposes or individual preference.

The user identification is given on all printouts. To define the user identification select the user id option.



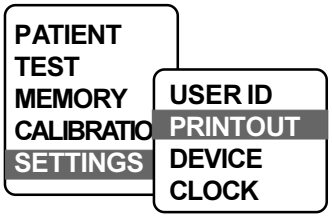
MENU Go to Main menu

ENTER Confirm displayed user ID



# Spiro Settings (Printout)

In the printout settings screen the information given on a printout is defined.



MENU Go to Main menu

CURSOR go to next line above

CURSOR go to next line below

CHOICE Change highlighted setting

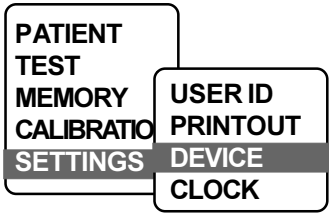
| | | | |
|---|---|---|---|
| Format | : | Meas1 | Select between: Measurement 1 or All (best three measurements) |
| FVC-Graph | : | Yes | yes; no |
| Flow Graph | | No | yes; no |
| Diagnosis | : | Yes | [1] yes; no |
| Lung Age | : | No | [2] yes: no |
| PEF (l/min) | : | No | yes; no |
| MENU | | CHOICE | |

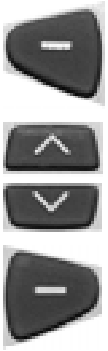
Notes: [1] Diagnosis: The diagnosis statement (printed or not printed) is in accordance with the defined `normals` (see next page and Section 2).

[2] Lung Age: The lung age (printed or not printed) is the calculated nominal age of the patient`s lungs according to the results obtained and the defined `normals` (see next page and Section 2). The value given is calculated using the actual FEV1 value against predicted FEV1 value for the age of the patient. No value will be given if the patient age is less than 18 years or if poor FEV1 test results have been obtained.

English

# Spiro Settings (Device)



MENU Go to Main menu

CURSOR go to line above

CURSOR go to line below

CHOICE Change highlighted setting

| | | |
|---|---|---|
| Normals | : | Knudson |
| Ethnic | : | C/H/B/A |
| FVC-Type | | Flow - Loop |
| Report-Type | : | Best |
| Unit | : | in/lb/°F |
| Date | : | mm-dd-yy |
| Language | : | English |

MENU CHOICE

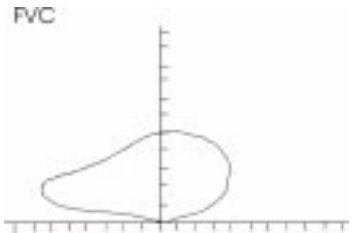
Select between:
Normals according to software and language - See section 2
W/B; C/H/BA
Vol = f(t); Flow = f(Vol); Flow - loop
Best; meas 1
in/lb/°F; cm/kg/°C
dd-mm-yy; yy-mm-dd; mm-dd-yy
Language options according to software

## Normals

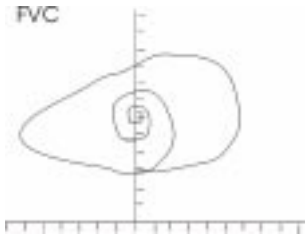
**The Normal value standards are given at the end of this section- 'Diagnosis and Norm Value Tables'.**

**DIAGNOSIS ACCORDING TO `ITS` RECOMMENDATIONS IS AVAILABLE WHEN CRAPO KNUDSON, OR COMPOSITE IS SET.**

Volume = f(t)




Flow = f(vol)




Flow - loop

English

# Changing the Mouthpiece

Align mouthpiece guides with guide slots in the sensor

# Changing the Mouthpiece

**WARNING**

**THE DISPOSABLE MOUTHPIECES ARE DESIGNED FOR ONE-TIME USE TO MINIMIZE THE DANGER OF CROSS CONTAMINATION. DO NOT USE THE MOUTHPIECE FOR MORE THAN ONE PATIENT.**

1. **Remove disposable mouthpiece by gently but firmly pulling it away from the device.**

2. **Discard the complete assembly.**

3. **Position new disposable mouthpiece and gently but firmly click it in position.**

**NOTE:** **The disposable mouthpiece can only be positioned in one direction and no force is necessary to insert it on the device. Ensure that the orientation is correct by checking the guide protrusion in sensor against the guide slot in the device.**

4. **Calibrate the sensor and unit as detailed following.**

English

# Calibration

To calibrate, enter the calibration screen from the main menu:

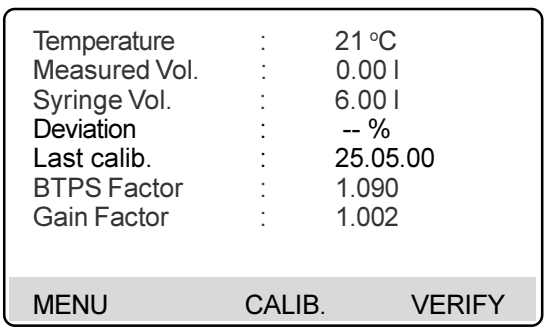
THE UNIT MUST BE CALIBRATED WITH THE FIRST PULMONARY FUNCTION TEST OF THE DAY AND AFTER EVERY SIGNIFICANT TEMPERATURE CHANGE.

**We additionally recommend that the device is calibrated before each new patient, that is every time the disposable Mouthpiece is changed.**

MENU — Return to main menu.

CALIB — Start calibration procedure and enter details (temp., vol. etc.), as detailed on the following pages. The calibration is accepted when the actual volume, and the volume calculated by the SP-2, is within a predefined limit. When a deviation greater than the limit is recorded, a message is displayed that the mouthpiece (screen) must be changed.

The following screen is displayed:

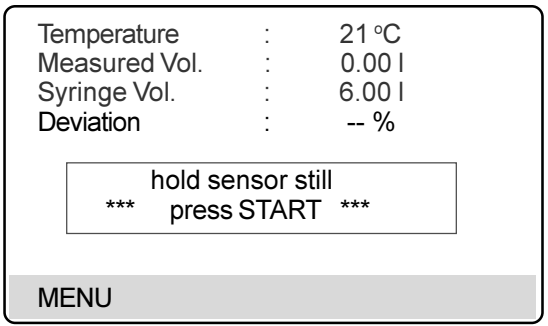


VERIFY — Verify calibration. The procedure is exactly the same as for CALIB (above), but the actual volume, and the volume calculated by the SP-2, must be within 3%. If this procedure is not within 3%, the unit must be recalibrated using the CALIB option above.

## Calibration Procedure

To calibrate the unit proceed as follows:

1. **Connect the calibration pump to the sensor. Ensure that there are no air leaks.**
2. **Press the up or down key (CALIB) to commence calibration.**
3. **Enter the ambient temperature and press enter to confirm.**




4. **Wait 1 second.**
5. **Press the START/STOP key .**

English

6. **Keeping the unit still, pump 3 to 6 liters of air through the Mouthpiece. While pumping, the unit records the volume being pumped through the Mouthpiece and indicates it on the display.**

7. **Press the START/STOP key when finished pumping.**

8. **Enter the reference volume of air (depending on the size of the calibration pump and times of pumping; e.g. a 2 litre pump pumped 3 times = 6 liters). Confirm with ENTER.**

9. **The message, `Calibration OK` appears on the display.**

If the message `EXCESSIVE DEVIATION! exchange screen` appears on the screen after a calibration, it indicates that the difference between the measured volume and the entered volume is too great. Check the temperature setting, the syringe volume and the entered syringe volume and recalibrate.

# Calibration Details

**Last Calibration** — date of last calibration

**BTPS** — **F**actor calculated BTPS (=> **B**ody **T**emperature, Ambient **P**ressure, **S**aturated with water vapor) value. This value compensates for the difference in inhaled and exhaled humidity. The unit is set for measuring exhaled volume (100% humidity, Temp 36.8°), and so when inhaled volume is measured this factor is applied. The SP-2 uses ambient temperature to calculate the BTPS factor. This is sufficient for accurate FIVC calculation. The formula used is as follows:

$$BTPS = 0.033 + \frac{273.15 + 36.8}{273.15 + Tu}$$

Where: Tu is the ambient temperature in degrees centigrade

0.033 is the equivalent to 760mmHg at 22°C

273.15 is degrees absolute

**Calibration Factor** — calculated value between measured and effective calibration air volume.

**Temperature** — ambient temperature in °C (or °F) dependent on device setting.

**Measured Volume** — air volume measured by the system from the calibration pump.

**Reference Volume** — entered air volume depending on the size of the calibration pump and times the air was pumped through the sensor; e.g. pumping 2 liters 3 times amounts to 6 liters (the recommended volume with a 2 litre pump is 4 liters and with a 3 litre pump 6 liters).

English

# Explanation of Measured Values

| | |
|---|---|
| **FVC** | **Forced (expiratory) Vital Capacity.** Volume achieved by the quickest possible exhalation after a maximal inhalation. |
| **$FEV_{0.5/1.0/3.0}$** | **Forced expiratory volume.** Lung volume in liters, measured after 0.5, 1.0 or 3 seconds forced expiration. |
| **$FEV_1$ / FVC** | forced expiratory air volume measured in the first second as a percentage of forced vital capacity. |
| **FEF** | **Forced Expiratory Flow Respiratory.** Flow in terms of differing lung volumes measured in liters per second. |
| **$FEF_{25-75\%}$** | flow speed of the expired air by 25 to 75% of the forced vital capacity (FVC). |
| **$FEF_{75-85\%}$** | flow speed of the expired air by 75 to 85% of the forced vital capacity (FVC). |
| **$FEF_{25\%}$** | flow speed of the expired air by 25% of the forced vital capacity (FVC). |
| **$FEF_{50\%}$** | flow speed of the expired air by 50% of the forced vital capacity (FVC). |
| **$FEF_{75\%}$** | flow speed of the expired air by 75% of the forced vital capacity (FVC). |
| **$FEF_{0.2-1.2}$** | averaged flow between 0.2 and 1.2 liters of the forced expired vital capacity. |
| **PEF** | **Peak Expiratory Flow.** |
| **MEF** | **Maximal Expiratory Flow.** |
| **$MEF_{75\%}$** | flow speed of the expired air by 25% of the forced vital capacity (FVC). |
| **$MEF_{50\%}$** | flow speed of the expired air by 50% of the forced vital capacity (FVC). |
| **$MEF_{25\%}$** | flow speed of the expired air by 75% of the forced vital capacity (FVC).<br>$MEF_{75\%} = FEF_{25\%}$<br>$MEF_{50\%} = FEF_{50\%}$<br>$MEF_{25\%} = FEF_{75\%}$ |

# Explanation of Measured Values

| | |
|---|---|
| **ERV** | **Expiratory Reserve Volume.** Possible further expiration starting from the normal expiration level. |
| **IRV** | **Inspiratory Reserve Volume.** Possible further inspiration starting from the normal inspiration level. |
| **TV** | **Tidal Volume.** Expirational and inspirational volumes during normal respiration. |
| **SVC** | **Slow Vital Capacity.** Lung volume measured from a complete expiration following a deep inspiration. |
| **MV** | **Expired or Minute Ventilation.** Volume of expired air in liters per minute measured over a minimum of one minute. |
| **MVV** | **Maximum Voluntary Ventilation.** Maximum volume of air which can be moved on expiration while breathing as deeply and as rapidly as possible. |
| **RR** | **Respiration Rate.** |
| **FMFT** | **Forced Mid-expiratory Flow Time.** Time difference between the 25% and 75% points of the FVC. |
| **FIVC** | **Forced Inspiratory Vital Capacity.** Inspiration volume achieved between a maximal expiration and a maximal inspiration. |
| **$FIV_{1.0}$** | forced inspiratory air volume in liters measured in the first second. |
| **$FIV_{1.0}$ / FIVC** | forced inspiratory air volume measured in the first second as a percentage of forced inspiratory vital capacity. |
| **$FIV_{1.0}$ / FVC** | forced inspiratory air volume measured in the first second as a percentage of forced expiratory vital capacity. |
| **PIF** | **Peak Inspiratory Flow.** Maximum inspiratory flow speed in liters / second. |
| **FIF (=MIF)** | **Forced (Maximum) Inspiratory Flow.** Maximum inspiratory flow in liters. |
| **$FIF_{50\%}$ ($=MIF_{50\%}$)** | flow speed by 50 % of the forced inspiratory vital capacity. |

English

## Self-test

A self test is initiated by the unit every time it is switched on. A table giving information for the service staff is displayed if an error is detected. To obtain a printout press the IrDA key when the table is displayed.

The unit should undergo a technical safety check every 12 months. This safety check should include the following:

- Visual inspection of the unit.
- Calibration of the sensor as detailed on page 26.

The test results must be documented.

## Lifed Items

There are no lifed items in the SP-2 Hand-Held Spirometry Unit

# Care & Maintenance

CAUTION:

ONLY THE DEVICE ITSELF CAN BE CLEANED - DO NOT ATTEMPT TO CLEAN THE DISPOSABLE MOUTHPIECE.

DO NOT, UNDER ANY CIRCUMSTANCES, IMMERSE THE UNIT INTO A CLEANING LIQUID OR STERILIZE WITH HOT WATER, STEAM, OR AIR.

## Cleaning the Unit

The unit can be cleaned with a soft damp cloth on the surface only. A standard hospital grade disinfectant may be used. Where necessary a domestic non-caustic cleaner can be used for grease and finger marks.

## Batteries

- Battery life for the two AA 1.5V alkaline batteries is 6 months under normal use defined as 10 patient sessions per week.
- Check batteries at least once a month for corrosion.
- Remove batteries if the unit is going to be stored for more than a month.
- Dispose of batteries properly. Welch Allyn Schiller recommends that local government recycling policy is followed.

English

# Spirometry Tips - How To Do It and Common Pitfalls and Problems

## How to Do It

To ensure an acceptable result, the FVC manoeuvre must be performed with maximum effort immediately following a maximum inspiration; it should have a rapid start and the spirogram should be a smooth continuous curve.

To achieve good results, carefully explain the procedure to the patient, ensuring that he/she is sitting erect with feet firmly on the floor (the most comfortable position). Note that for child patients, vital capacity can be greater in the standing position. Apply a nose clip to the patient's nose (this is recommended but not essential) and urge the patient to:

- breathe in fully;
- seal his/her lips around the mouthpiece;
- blast air out, as fast and as far as you can until the lungs are completely empty;
- breathe in again as forcibly and fully as possible.

If only peak expiratory flow is being measured then the patient need only exhale for a couple of seconds. Essentials are:

- a good seal on the mouthpiece and
- very vigorous effort right from the start of the manoeuvre and continuing until absolutely no more air can be exhaled.
- no leaning forward during the test.

# Spirometry Tips - How To Do It and Common Pitfalls and Problems

Remember, particularly in patients with airflow obstruction, that it may take many seconds to fully exhale. It is also important to recognize those patients whose efforts are reduced by chest pain or abdominal problems, or by fear of incontinence, or even just by lack of confidence. There is no substitute for careful explanation and demonstration - demonstrating the manoeuvre to the patient will overcome 90% of problems encountered and is critical in achieving satisfactory results. Observation and encouragement of the patient's performance are also crucial. Be sure to examine the spirogram for acceptability and reproducibility, (correction factors to the measurements for BTPS are automatic during calibration (see Calibration section).

Attention to fine detail in the performance of the breathing manoeuvre is critical to obtaining reliable results.

At least three technically acceptable manoeuvres should be obtained, ideally with less than 0.2 L variability for FEV1 (and FVC) between the highest and second highest result. Quote the largest value. The American Thoracic Society (ATS) provides the following guidelines for manoeuvre performance.

## FVC

- Minimum of 3 acceptable blows
- A rapid start is essential: this is defined as a back-extrapolated volume of <5% of FVC or 0.15 L, whichever is greater.
- At least 6 second expiration
- End of test - no change in volume for at least 1 second after exhalation time of 6 seconds; or FET >15 seconds; or stopped for clinical reasons
- Spirometer temperature between 17 and 40 degrees Celsius; measure spirometer temperature to one degree Celsius
- Use of nose clip is encouraged
- Sitting or standing
- Reproducibility: the highest and second highest FVC should agree to within 0.2L

English

# Spirometry Tips -How To Do It and Common Pitfalls and Problems

## FEV1

- As for FVC
- Take largest FEV1 even if not from the same curve as the best FVC
- Zero time determined by back-extrapolation - extrapolated volume should be <5% of FVC or 0.15 liters, whichever is greatest
- Smooth, rapid take off with no: hesitation, cough, leak, tongue obstruction, glottic closure, Valsalva or early termination
- Reproducibility: the highest and second highest FEV1 should agree to within 0.2L

## Patient-Related Problems

The most common patient-related problems when performing the FVC manoeuvre are:

- Submaximal effort
- Leaks between the lips and mouthpiece
- Incomplete inspiration or expiration (prior to or during the forced manoeuvre)
- Hesitation at the start of the expiration
- Cough (particularly within the first second of expiration)
- Glottic closure
- Obstruction of the mouthpiece by the tongue
- Vocalization during the forced manoeuvre
- Poor posture.

Once again, demonstration of the procedure will prevent many of these problems, remembering that all effort-dependent measurements will be variable in patients who are uncooperative or trying to produce low values.

Glottic closure should be suspected if flow ceases abruptly during the test rather than being a continuous smooth curve. Recordings in which cough, particularly if this occurs within the first second, or hesitation at the start has occurred should be rejected. Vocalization during the test will reduce flows and must be discouraged - performing the manoeuvre with the neck extended often helps.